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Umeno

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(54) **POWER CONNECTOR**

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(52) **U.S. Cl.**

CPC ***H01R 13/629*** (2013.01); ***G02B 6/3817*** (2013.01); ***G02B 6/3897*** (2013.01); ***H01B 11/22*** (2013.01); ***H01R 11/30*** (2013.01); ***H01R 13/6205*** (2013.01)

(58) **Field of Classification Search**

CPC G02B 6/3817; G02B 6/3897; G02B 6/403; G02B 6/3886; H01B 11/22

USPC 385/53–60, 75, 78; 438/38

See application file for complete search history.

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(57) **ABSTRACT**

A power and data connector includes an extension that protrudes from a lip surface. The extension is configured to mate with an electronic device. A connection surface at a terminal end of the extension separately surrounds openings, through which power interfaces extend.

20 Claims, 3 Drawing Sheets

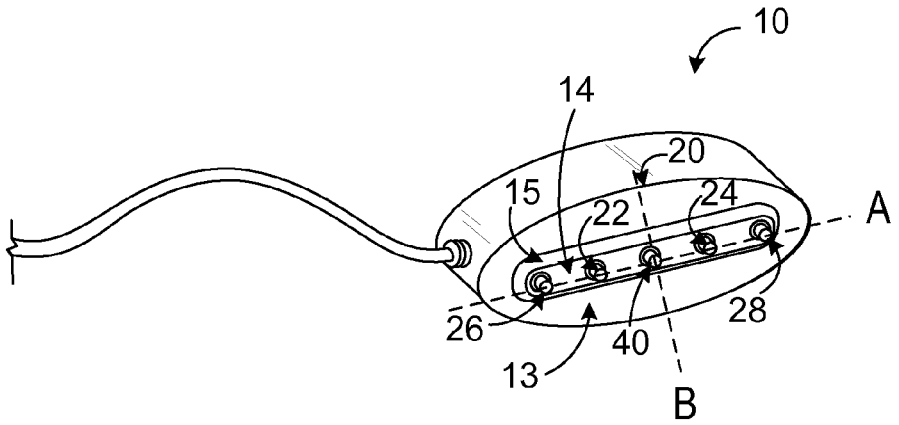

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FIG. 1

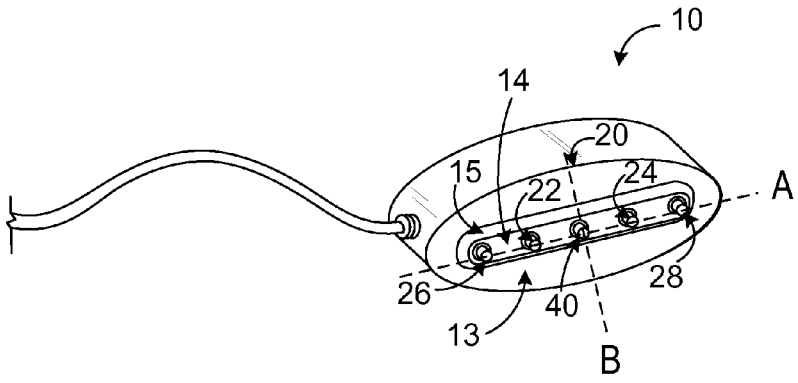


FIG. 2

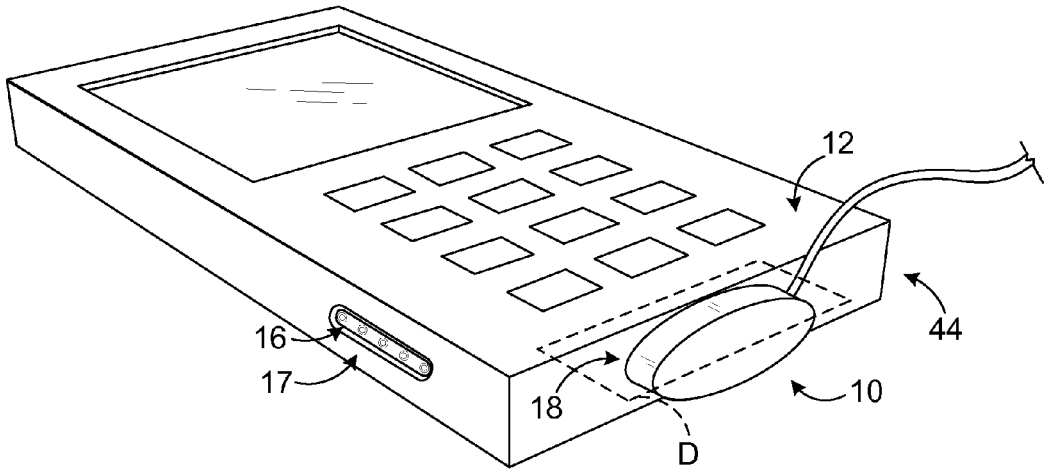


FIG. 3

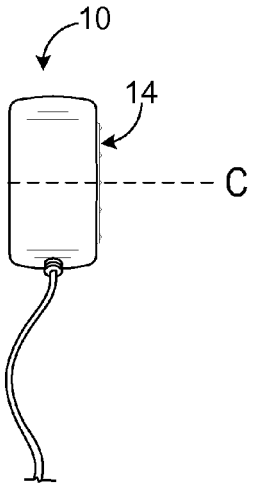


FIG. 4

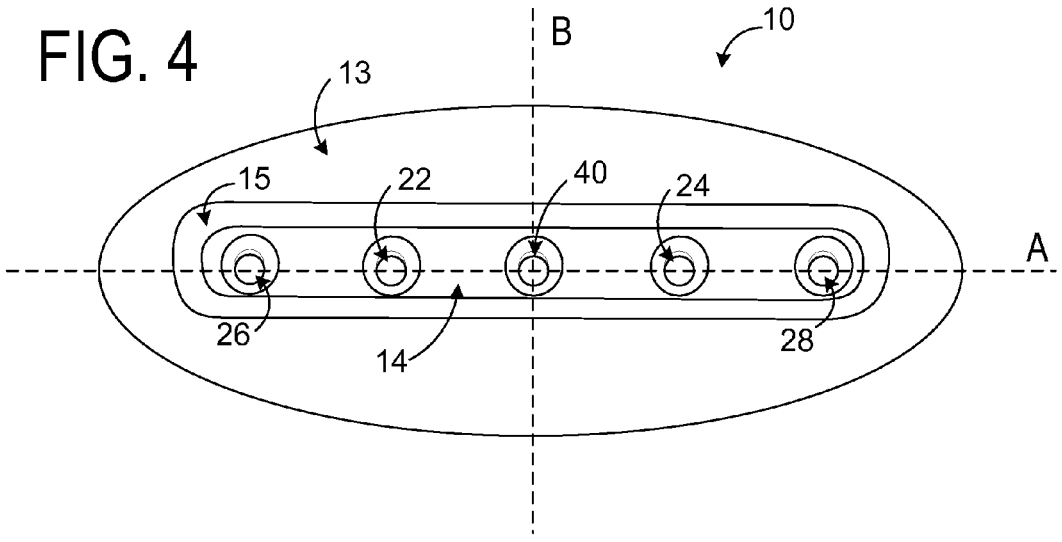
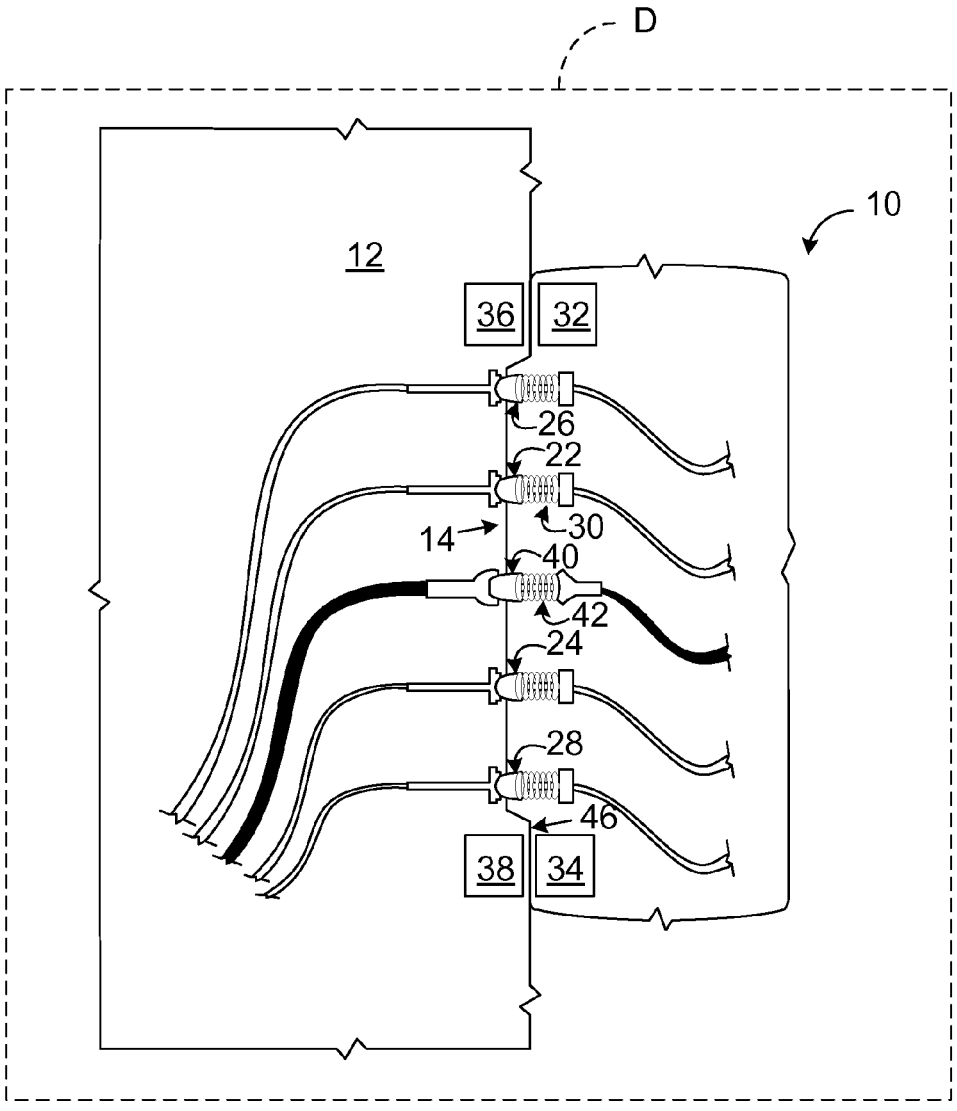


FIG. 5



POWER CONNECTOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/034,334 filed Sep. 23, 2013, which is a continuation of U.S. patent application Ser. No. 13/070,331, filed Mar. 23, 2011, now U.S. Pat. No. 8,596,881, which claims priority to U.S. Provisional Patent Application No. 61/421,587, filed Dec. 9, 2010, the entirety of each of which are hereby incorporated herein by reference.

BACKGROUND

Electronic devices often have one or more interfaces for receiving electrical power and/or data. The design of such interfaces has a profound effect on functional and aesthetic aspects of the electronic device.

SUMMARY

A power and data connector includes an extension that protrudes from a lip surface. The extension is configured to mate with an electronic device. A connection surface at a terminal end of the extension separately surrounds openings, through which power interfaces extend.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a power and data connector in accordance with an embodiment of the present disclosure.

FIG. **2** shows an electronic device including a plurality of connector receptors configured to selectively couple with the power and data connector of FIG. **1**.

FIGS. **3** and **4** show the power and data connector of FIG. **1**.

FIG. **5** shows a schematic cross section of the power and data connector of FIG. **1** coupled to the electronic device of FIG. **2**.

DETAILED DESCRIPTION

FIG. **1** shows a nonlimiting example of a power and data connector **10**. Power and data connectors in accordance with the present disclosure, such as power and data connector **10**, provide a mechanically simple and aesthetically pleasing mechanism for delivering power and/or data to and/or from an electronic device, such as electronic device **12** of FIG. **2**.

As described in more detail below, power and data connectors in accordance with the present disclosure include a planar connection surface that is substantially flat and protrudes in front of the rest of the power and data connector. For example, FIG. **1** shows an example planar connection surface **14** of power and data connector **10**. The planar connection surface is designed to mate with a planar receptor surface of the electronic device. FIG. **2** shows an example planar receptor surface **16** of electronic device **12**. FIG. **1** also shows a lip surface **13** and a tapered extension **15**. The tapered extension

15 protrudes from the lip surface **13**, and the planar connection surface **14** is located at a terminal end of the tapered extension.

Magnetic attractors of the power and data connector and the electronic device magnetically hold the planar connection surface in place relative to the planar receptor surface. FIG. **2** shows power and data connector **10** magnetically held in place relative to a planar receptor surface (hidden by power and data connector **10**). When held in this manner, various power interfaces and/or optical or electrical data interfaces of the power and data connector are operatively coupled to complementary power interfaces and optical data interfaces of the electronic device. As such, power and/or data may be transferred to and/or from the electronic device via the power and data connector.

Because the connector surface and the receptor surface are planar and magnetic force is used to hold the power and data connector to the electronic device, the electronic device can be designed with a substantially smooth surface. It is believed that the substantially smooth surface allowed by the herein disclosed power and data connector is aesthetically pleasing, is resistant to mechanical failures associated with mechanically complicated designs, is easy to keep clean, and provides countless other benefits.

Planar connection surface **14** is symmetrical about a first axis A and symmetrical about a second axis B that is perpendicular to axis A. Axis A and axis B are perpendicular to a connection axis C (shown in FIG. **3**) of the planar connection surface. The symmetrical shape of the planar connection surface allows the power and data connector to be connected to an electronic device in either of at least two different orientations. In other words, the power and data connector may be connected with a first orientation or a second orientation that is rotated one hundred eighty degrees relative to the first orientation.

Power and data connectors in accordance with the present disclosure may include one or more pairs of power interfaces. Such power interfaces may be electrical conductors, for example. In the illustrated example, power and data connector **10** includes a first power interface **22** and a second power interface **24** on planar connection surface **14**. As shown in FIGS. **1** and **4**, first power interface **22** and second power interface **24** are aligned with axis A. Furthermore, first power interface **22** and second power interface **24** are each spaced the same distance away from axis B so that the first power interface and the second power interface are symmetrical about axis B.

Each power interface is configured to operatively couple with a complementary power interface of a power and data connector receptor such that electrical power is transferred between the first power interface and the complementary power interface. As one nonlimiting example, one power interface may be held at a first voltage and the other power interface may be held at a different voltage such that a voltage differential is established for providing a direct current for powering an electronic device. The symmetrical arrangement of the power interfaces allows the power and data connector to be orientation agnostic.

Power and data connectors in accordance with the present disclosure may include one or more power interfaces configured to ground the power and data connector. In the illustrated example, power and data connector **10** includes a ground power interface **26** and a ground power interface **28**. In other embodiments, the planar connection surface or another aspect of the power and data connector may be used to ground the power and data connector.

In the illustrated embodiment, power and data connector **10** includes two working power interfaces for establishing a DC voltage and two ground power interfaces for grounding the power and data connector. However, power and data connectors may include virtually any number of working and/or grounding power interfaces without departing from the scope of this disclosure.

As shown in FIG. **3**, the power interfaces may extend parallel to connection axis C past the planar connection surface **14** and all other portions of the power and data connector. In other words, the power interfaces may be the forward most aspect of the power and data connector. In other embodiments, the power interfaces may be recessed into the planar connection surface parallel to the connection axis C. As discussed below, optical interface(s) may extend or recede similar to the power interfaces. In general, the amount of extension and/or recession will be relatively minor—e.g., less than two millimeters. Further, any extension and/or recession may be accommodated by complementary recession and/or extension of the power and data connector receptor, such that reliable connections can be established between the power and data connector and the electronic device.

FIG. **5** shows a cross-sectional view of a plane D, which is illustrated in FIG. **2**. As shown in FIG. **5**, a power interface, such as power interface **22**, may be operatively connected to a connection assistant **30**. Connection assistant resiliently biases the power interface past the planar connection surface **14** parallel to connection axis C. The connection assistant provides the power interface with a variable amount of extension so that a solid contact may be made with a complementary power interface of the electronic device. In some embodiments, the electronic device may alternatively or additionally include a connection assistant to resiliently bias the power interfaces of the electronic device. The connection assistant may include a spring in some embodiments.

As shown in FIG. **5**, power and data connector **10** includes a first magnetic attractor **32** and a second magnetic attractor **34** that are configured to cooperate with magnetic attractor **36** and magnetic attractor **38** of electronic device **12** to magnetically hold the power and data connector **10** in place relative to the electronic device. The magnetic attractors may be flush with or recessed behind the planar connection surface **14**, as shown in FIG. **5**. In some embodiments, one or more magnetic attractors may alternatively or additionally be flush with or recessed behind the lip surface and/or the tapered extension. In some embodiments, the magnetic attractors may include a permanent magnet and/or an electromagnet. While the illustrated embodiment shows a power and data connector that includes two magnetic attractors, it is to be understood that virtually any number of magnetic attractors may be used without departing from the scope of this disclosure.

Power and data connectors in accordance with the present disclosure may include one or more electrical or optical interfaces configured to transmit data signals. In the illustrated example, power and data connector **10** includes optical interface **40** in the form of an optical fiber connector that terminates a fiber optic cable capable of transmitting data signals in the form of light.

As shown in FIG. **4**, optical interface **40** is aligned with axis A and axis B at a center of planar connection surface **14**. In some embodiments, a pair of optical interfaces may be aligned with axis A and spaced the same distance away from axis B so that the pair of optical interfaces are symmetrical about axis B.

Like the power interfaces, the optical interface is configured to operatively couple with a complementary optical interface of a power and data connector receptor. In this way, optical signals may be transferred between the optical interface of the power and data connector and the complementary optical interface of the electronic device.

As shown in FIG. **5**, optical interface **40** may be operatively connected to a connection assistant **42** resiliently biasing that optical interface past planar connection surface **14**.

Turning back to FIG. **2**, electronic device **12** includes a housing **44** and a plurality of power and data connector receptors to selectively couple with power and data connectors. In the illustrated embodiment, electronic device includes an empty power and data connector receptor **17** and a power and data connector receptor **18** that is occupied by power and data connector **10**. A device may include virtually any number of power and data connector receptors without departing from the scope of this disclosure.

The power and data connector receptors may be formed as an integral part of the device chassis or housing so that there is not a separate user-visible connector housing. Furthermore, the power and data connector may include a tapered opening that recedes to the planar receptor surface at its terminal end. The tapered opening may be sized and shaped to mate with the tapered extension of the power and data connector. The tapered arrangement helps guide the power and data connector into a mated arrangement with the power and data connector receptor in either of two orientations (i.e., 180 degree rotation). In the mated arrangement, the magnetic attractors can hold the power and data connector in place.

The power and data connector receptors may be located at different sites around housing **44**. An auxiliary device or power source may be connected to any of the different connector receptors via a power and data connector, thus providing connection flexibility that may facilitate using the electronic device in a desired orientation, with a desired case or covering, and/or with a desired grip.

Furthermore, when plural connector receptors are included in the same electronic device, two or more auxiliary devices (or an auxiliary device and a power source) may be simultaneously connected to the electronic device via different power and data connectors. In such cases, the plurality of connector receptors may be operatively connected to one another such that power received via one connector receptor may be output via another connector receptor; and data received via an optical interface of one connector receptor may be output via an optical interface of another connector receptor. In this way, power and/or data may not only be delivered to the electronic device, but also through the electronic device to another auxiliary device.

In general, each power and data connector receptor may be configured to complement the power and data connector. As such, each of the plurality of power and data connector receptors may include a receptor surface **16**. In some embodiments, the receptor surface may be planar. Furthermore, the receptor surface may be recessed less than six millimeters from the housing so as to provide a substantially continuous and uninterrupted surface from the housing and across the connector receptor. The overall smoothness of the connector receptor in relation to the housing provides a clean appearance that does not include any protrusions that can be easily broken or large gaps into which debris and other contaminants may collect. The overall smoothness is also thought to produce an aesthetically pleasing appearance.

Like the corresponding planar connection surface of the power and data connector, the connector receptor may be substantially symmetrical. Furthermore, the connector receptor may include power interfaces and/or optical interfaces positioned to align with the corresponding power interfaces and optical interfaces of the power and data connector when

the power and data connector is magnetically held to the electronic device. To facilitate such magnetic holding, the connector receptor may include one or more magnetic attractors flush with or recessed behind the receptor surface.

It is to be understood that the configurations and/or approaches described herein are exemplary in nature, and that these specific embodiments or examples are not to be considered in a limiting sense, because numerous variations are possible. The specific routines or methods described herein may represent one or more of any number of processing strategies. As such, various acts illustrated may be performed in the sequence illustrated, in other sequences, in parallel, or in some cases omitted. Likewise, the order of the above-described processes may be changed.

The subject matter of the present disclosure includes all novel and nonobvious combinations and subcombinations of the various processes, systems and configurations, and other features, functions, acts, and/or properties disclosed herein, as well as any and all equivalents thereof.

The invention claimed is:

1. A power and data connector, comprising:

a lip surface;

an extension protruding from the lip surface, the extension configured to mate with an electronic device;

a connection surface at a terminal end of the extension, the connection surface being functionally symmetrical about a first axis and functionally symmetrical about a second axis perpendicular to the first axis, the first axis and the second axis being perpendicular to a connection axis of the connection surface, the connection surface surrounding separate first and second openings equally spaced from the second axis;

a first power interface extending through the first opening, the first power interface aligned with the first axis; and

a second power interface extending through the second opening, the second power interface aligned with the first axis.

2. The power and data connector of claim **1**, where the extension is configured to cooperate with one or more corresponding magnetic attractors of the electronic device to hold the power and data connector to the electronic device via magnetic force.

3. The power and data connector of claim **2**, where the extension includes a magnet.

4. The power and data connector of claim **3**, where the extension includes a permanent magnet.

5. The power and data connector of claim **1**, where the extension includes a magnetically attractable material.

6. The power and data connector of claim **1**, where the connection surface is planar.

7. The power and data connector of claim **1**, where a portion of the connection surface is between the first and second openings.

8. A connector, comprising:

a lip surface;

an extension protruding from the lip surface, the extension configured to mate with an electronic device;

a connection surface at a terminal end of the extension, the connection surface being functionally symmetrical about a first axis and functionally symmetrical about a second axis perpendicular to the first axis, the first axis and the second axis being perpendicular to a connection axis of the connection surface, the connection surface surrounding separate first and second openings;

a first power interface extending through the first opening, the first power interface aligned with the first axis; and

a second power interface extending through the second opening, the second power interface aligned with the first axis, the first power interface and the second power interface equally spaced from the second axis.

9. The connector of claim **8**, where the extension is configured to cooperate with one or more corresponding magnetic attractors of the electronic device to hold the power and data connector to the electronic device via magnetic force.

10. The connector of claim **9**, where the extension includes a magnet.

11. The connector of claim **9**, where the extension includes a permanent magnet.

12. The connector of claim **9**, where the extension includes a magnetically attractable material.

13. The connector of claim **8**, where the connection surface is planar.

14. The connector of claim **8**, where a portion of the connection surface is between the first and second openings.

15. A connector, comprising:

a lip surface;

an extension protruding from the lip surface, the extension configured to mate with an electronic device;

a planar connection surface at a terminal end of the extension, the connection surface being functionally symmetrical about a first axis and functionally symmetrical about a second axis perpendicular to the first axis, the first axis and the second axis being perpendicular to a connection axis of the connection surface, the connection surface surrounding separate first and second openings;

a first power interface extending through the first opening, the first power interface aligned with the first axis; and

a second power interface extending through the second opening, the second power interface aligned with the first axis, the first power interface and the second power interface equally spaced from the second axis.

16. The connector of claim **15**, where the extension is configured to cooperate with one or more corresponding magnetic attractors of the electronic device to hold the power and data connector to the electronic device via magnetic force.

17. The connector of claim **16**, where the extension includes a magnet.

18. The connector of claim **16**, where the extension includes a permanent magnet.

19. The connector of claim **16**, where the extension includes a magnetically attractable material.

20. The connector of claim **15**, where a portion of the connection surface is between the first and second openings.

* * * * *